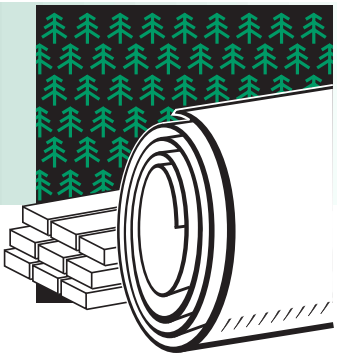
FOREST PRODUCTS

Project Fact Sheet



Environmental Influences on Wood Chemistry and Density of *Populus* and Loblolly Pine

Benefits

- Determines the proper environmental and silvicultural conditions for obtaining specific physical and chemical properties of wood from two tree species
- Provides empirical models for predicting the quality of *Populus* and loblolly pine wood in managed plantations
- Ensures that adequate supplies of high-quality wood and pulp are available to the wood products industry
- Reduces the waste of feedstock that is not suitable for manufacturing wood products
- Is complementary to studies underway to select tree genotypes associated with desirable wood properties

Applications

Publication of these findings will be useful to forestry managers in determining the proper environmental/silvicultural conditions for growing desirable wood. When coupled with the genetic information being developed in parallel, it will become possible to develop and manage tree plantations capable of providing the wood products industry with sufficient supplies of high-quality feedstock at all times.

Project Will Provide a Clear Understanding of the Effects of Environmental and Silvicultural Practices on Wood Quality

Demand is increasing for products manufactured from wood having specific qualitative traits. To meet expectations, researchers have made progress in controlling the genetic make-up of fast-growing trees in intensively managed tree plantations. More recently, they have also demonstrated that environment can affect the properties of wood derived from these forests. Variables such as the amount of light, carbon dioxide, ozone, water, temperature, soil nutrients and acidity, and soil texture can affect carbon allocation and tree growth. Soil moisture can influence properties such as the relative amounts of earlywood and latewood, tracheid diameter, and thickness of cell walls. Environmental variables can have positive or negative effects on wood-specific gravity.

This project is a continuation of a successfully completed effort of the research team to analyze wood properties in loblolly pine and hybrid poplars, and identify the quantitative trait loci (QTLs) or DNA sequences associated with each of the properties. The new focus will be on the environmental and silvicultural practices that can affect the quality of the wood that is grown. The physical and chemical changes will be identified, and predictive models of these effects will be developed.

Oak Ridge National Laboratory and the National Renewable Energy Laboratory will work cooperatively with the U.S. Forest Service, North Carolina State University, and International Paper Company on this four-year project.

Figure 1.

Detecting water movement in 4-year-old cottonwood using heat-pulse probes.

Project Description

Goal: To determine the extent to which environmental and silvicultural practices can affect the physical and chemical properties of wood in *Populus* and loblolly pine, and to develop predictive models for these environmental influences.

Samples of *Populus* and loblolly pine wood will be collected from trees grown in controlled environmental conditions with regard to irrigation and fertilization practices. Within each experimental unit, genetic differences will be characterized to account for the effects of genetics on wood quality. Wood from six clones of the rapidly growing *Populus* species will be obtained at a plantation managed by International Paper in Sumter, South Carolina. Climatic, silvicultural, and biometric data will be available for analysis during the first year of the study. Wood for the loblolly pine study will come from open-pollinated tree families from the Proto FACE Site in Wake County, North Carolina. Data for this species will not become available until years 3 and 4 of the study.

Progress & Milestones

- This project is a continuation of the successful project, "Development and Validation of Marker-Aided Selection Methods for Wood Property Traits."
- Two rapid assays were successfully developed for use with small amounts of material from *Populus* and loblolly pine: (1) the pyrolysis-molecular beam mass spectroscopy (pyMBMS) to determine the chemical composition of cell walls; and (2) the computer-assisted tomography X-ray densitometry (CT scan) to define wood-specific gravity, annual ring boundaries, and intraring-specific gravity.
- Nine QTLs were detected in loblolly pine related to wood-specific gravity, and 5 were found for microfibril angle; twelve unique QTLs were detected that influence cell-wall chemistry.
- Significant differences were found in the chemical contents of the North Carolina populations compared to the Oklahoma trees, and the analysis suggests that QTLs interact with the environmental location.
- The lignin content and syringyl-to-guaiacyl ratios were determined across 310 full-sib *Populus* progeny; correlations were studied among glucan, xylan, arabinan, mannan, and extractives content.
- Year 1 of the present study will focus on determining the environmental variables that affect the physical and chemical properties of *Populus*; a **Year 1 Milestone** will be publishing the relationships between the growth of Populus and the environmental and silvicultural influences present.
- Year 2 tasks will involve spatial and temporal resolution of the wood property differences for Populus, and modeling the environmental effects on *Populus* wood; a **Year 2 Milestone** will be a *Populus* Projection of Latent Structure (PLS) predictive model.
- Year 3 will be dedicated to analyzing the silvicultural and environmental components that influence the chemical and physical properties of loblolly pine; a **Year 3 Milestone** is to publish the relationships between the growth of loblolly pine and the environmental components.
- Year 4 will focus on spatial and temporal resolution of the wood property differences for loblolly pine; a **Year 4 Milestone** will be development of a PLS predictive model for loblolly pine's chemical and physical properties. The *Populus* model developed in year 2 will be verified with data collected on this species in years 3 and 4.

Project Partners

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North Carolina State University

International Paper Company

U.S. Forest Service

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May 2002